PhD Topic: DIVERSITY, HABITAT PREFERENCE AND SEASONAL DISTRIBUTION OF BUTTERFLIES IN VARIOUS HABITATS OF RANCHI

A Research Proposal Submitted to the

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SESSION: 2020

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INTRODUCTION

Biodiversity is not evenly distributed in the world (von Humboldt, 1849). From arid deserts and luxuriant tropical rainforests, to lowland forests and alpine grasslands, sharp environmental changes are easily noticeable. For more than two centuries, the early foundations of biogeography have been assembled by generations of explorers and naturalists such as Willdenow, von Humboldt, Wallace, and Darwin, detailing multiple examples of environmental variations along latitude and elevation (see Lomolino, 2001 for an historical perspective). The negative correlations of species richness with decreasing latitude and increasing elevation are among the most universal ecological relationships known. They were first interpreted to be driven by a decrease in favourable climatic conditions with decreasing latitude and increasing elevation (Wildenow, 1805).

Survivor planet- the Earth, is a huge biological system where we- humans- inhabit. It's the complex globe of multiple great biomes. These biomes serve as composite market of different biological systems. Biological systems do not only involve humans but it is a marvellous blend of plants, animals, rivers, mountains and climate. If given a thought to a simple hypothetical situation that- one of the above elements is over dominated by the other, one will definitely point out the human beings lie head high to conquer these natural elements, today.

The diversity of life is one of the most striking aspects of our planet; hence knowing how many species inhabit Earth is among the most fundamental questions in science (Mora et al., 2011). Today, there is an urgent need of not only the in-depth research on diversity but also to induce it for conservation. Diversity studies leads to the destined path of conservation. Biodiversity is the variety of different types of life found on the Earth and the variations within species. It is a measure of the variety of organisms present in different ecosystems. The richness of biodiversity depends on the climatic conditions and area of the region.

Global diversity patterns are one of the most dynamic systems designed by nature. Truly, this is the present scenario of global biodiversity which seem to be under the threat of human beings and its related ambiguities. Insects form one of the major components of this biological diversity. By far now, they are the most successful living organisms on Earth, starting their existence from Devonian period to the present scenario dedicated for conserving biodiversity. World Wildlife Fund strictly quotes- "The world is currently undergoing a very rapid loss of biodiversity comparable with the great mass extinction events that have previously occurred only five or six times in the Earth‟s history" This is an alarming call of these tiny scraps of

biodiversity which now have scarce appearance surrounding the huge human kingdom. In sustainable environment, resources should be utilized in such a way that it not only satisfies the need of the present generation but also saves it for the future generations.

Prior research work in Butterfly Prominent stalwarts have worked on butterflies as well as moths whose works are frequently referred even today! Numerous prior contributions were given in the field of Lepidopterology which are chronologically listed in Table 1.

Major contributions in the field of Butterfly (Lepidopterology)

Sl No	Contributions by Stalwarts in the field of Butterfly (Lepidopterology)	Year
01	Lepidoptera of Ceylon – F. Moore	1880-1881
02	The Butterflies of India, Burma and Ceylon Vol-I Lionel de Niceville & G. F. L. Marshall	1883
03	The Butterflies of India, Burma and Ceylon Vol-II- Lionel de Niceville	1886
04	The Butterflies of India, Burma and Ceylon Vol-I- Lionel de Niceville	1890
05	Lepidoptera Indica- Moore	1890
06	Hesperiidae Indicae- E.Y.Watson	1891
07	Lepidoptera Indica- Swinhoe	1907
08	Butterflies of India (Antram, 1924)	1924
09	Identification of Indian Butterflies, reprinted in 1932 (Evans, 1932)	1927
10	Fauna of British India- Vol-I (Talbot, 1939)	1939
11	Fauna of British India- Vol-II (Talbot, 1947)	1947
12	The Butterflies of the Indian Region (Wynter Blyth, 1957)	1957
13	Butterflies of the Western Ghats, India (including Sri Lanka): A biodiversity assessment of a threatened mountain system (Gaonkar, 1996)	1996

With the beginning of the 21st Century, many institutes got involved in the Rhopaloceran studies and therefore, provided wide literature sources in India. In 2008, Zoological Survey of India published a classic handbook on common butterflies of Uttarakhand (Kumar, 2008). A year later, ZSI published handbook on butterflies of Himachal Pradesh (Arora et al., 2009). Later on after few years, Kerala Forest Research Institute published detailed report on butterflies of Nilgiri Biosphere Reserve (Mathew, 2011).

In the ancient Greek ‘lepido’ means scales and ‘ptera’ means wings, hence the term Lepidoptera means insects with scaly wings. The term „Lepidoptera“ was coined by Linnaeus in 1735.

Order Lepidoptera is considered to be one of the largest orders of Class Insecta, comprising of moths and butterflies. The scientific study of Lepidoptera is known as Lepidopterology.

Butterfly Diversity in Indian Sub-continent

Butterflies were no longer unknown to the naturalists and keen researchers. Diversity studies of butterflies were not known until the early 19th century.

Approximately, 1,74,250 lepidopteran species are described, of which estimated number of butterfly species are 17,950 and rest make up for moths (Palot et al., 2012). Majority of the butterfly species occupy the tropics, but certain diversity has also been observed other continents around the globe, except Antarctica. The numerical family wise distribution of butterflies around the World, Indian region and Western Ghats is shown in Table 2.

Researchers, academicians and amateurs have started studying the butterfly diversity in different parts of India. In 2012, team of academicians conducted the studies on biodiversity of butterflies in Ambasamudram taluka of Tirunelveli district of Tamil Nadu and recorded a total of 23 species belonging to 19 genera, of which, members of family Nymphalidae was found to be maximum (Elanchezhyan et al., 2012).

Table 2: Family-wise distribution of butterflies recorded from the World, Indian region & Western Ghats

Sl No	Families	World	Indian Region	Western Ghat
01	Papilionidae	573	107	19
02	Pieridae	1200	109	35
03	Nymphalidae	6000	522	97
04	Lycaenidae	6000	443	103
05	Hesperiidae	3050	321	80
	Total	16823	1502	334

(Source: Butterflies (Lepidoptera: Rhopalocera) of Western Ghats, Zoological Survey of India, Calicut)

Collaborative team of authors have studied butterfly diversity in 9 different talukas of Tiruvallur district of Tamil Nadu and recorded a total of 97 species from 63 genera, of which members of family Nymphalidae were found to maximum (Prabakaran et al., 2014). Academicians from University of Madras also carried out studies on butterfly diversity in the city of Chennai and observed a total of 47 species of butterflies (Thangapandian et al., 2014).

Studies on biodiversity of butterflies was conducted at four different sites in Eastern Ghats and a total of 70 butterfly species were identified (Venkata Ramana, 2010). The author also observed the migratory butterflies along with the mating behaviour of butterflies.

Not only in India, but studies on butterfly diversity is also being carried out in neighbouring countries of India. Studies on butterflies were conducted in Chuadanga district of Bangladesh and total of 49 species were recorded for the first time (Shihan, 2014). Team of authors from Azad Jammu and Kashmir in Pakistan also carried out studies on diversity of butterflies and reported a total of 28 species from 7 families and also showed that maximum diversity of butterflies was observed in Shaeed Gali and Gari Dopatta whereas lower diversity was observed in Kohala (Khan et al., 2004).

How climatological seasonal factors will influence distribution of Rhopalocerans ?

The India Meteorological Department (IMD) designates four climatological seasons:

Winter, occurs from December to March. The year's coldest months are December and January, when temperatures average around 10–15 °C in the northwest; temperatures rise as one proceeds towards the equator, peaking around 20–25 °C in mainland India's southeast.

Summer or pre-monsoon season lasts from April to June (April to July in northwestern India). In western and southern regions, the hottest month is April; for northern regions, May is the hottest month. Temperatures average around 32–40 °C in most of the interior.

Monsoon or rainy season lasts from July to September. The season is dominated by the humid southwest summer monsoon, which slowly sweeps across the country beginning in late May or early June. Monsoon rains begin to recede from North India at the beginning of October. South India typically receives more rainfall.

Post-monsoon or autumn season lasts from October to November. In north-western India, October and November are usually cloudless. Tamil Nadu receives most of its annual precipitation in the northeast monsoon season.

Climate change is one the major factors affecting the developmental as well as physiological changes in insects. Amongst varied insects, butterflies are one such group which is sensitive to the environment. In West Bengal, seasonal diversity of butterflies was studied in Upper Neora Valley National Park and revealed a total of 161 species of butterflies (Sengupta et al., 2014) and showed that members of family Nymphalidae were maximum and concluded that autumn followed by monsoon showed high species richness due to abundance in vegetation which provides food to larval stages.

Along with climate, the altitudinal gradient also affects the butterfly diversity. Duo authors from Kolkata (Ghorai & Sengupta, 2014) studied distribution of papilionid butterflies along with their larval host plants and explored a total of 26 species of butterflies and 35 species of plants serve as larval host plants for these butterflies. Along with that the authors also reported monophagous nature of butterflies.

Climate change has also affected the lepidopteran behavior. Migration plays an important role in life of lepidopterans. Such an important behavior of lepidopterans is highly influenced by climate change. Study in UK was conducted on the migratory species of lepidopterans and showed that migration in lepidopterans is strongly influenced with the rising temperatures (Sparks et al., 2007).

Hence with the increase in temperature, there is an increase in the migratory species of lepidopterans which will have strong invasion consequences. Multiple factors affect the community structure of lepidopterans.

Duo authors from Hungary in detailed reviewed the major climatic factors influencing the existence of lepidopteran species including the temperatures, atmospheric CO2 concentration, drought, etc. (Hufnagel & Kocsis, 2011). They also concluded with a view that there are certain adaptable species and also conditions necessary for successful invasion to new territories.

Combining factors like climate change and habitat type play very important role in diversity of butterflies. Collaborative team of authors conducted study on seasonal population and migration of butterflies in coastal plains of Kalpakkam of South India (Ramesh et al., 2013) and revealed a total of 66 species of butterflies and showed that the butterfly diversity was higher during the beginning and end of North east Monsoon.

LIFE CYCLE OF A BUTTERFLY

Unlike other insects, butterflies do not show nymph stage. Hence, being one of those holometabolous insects, butterfly undergoes complete metamorphosis. The life span of a butterfly shows four distinct stages in their life cycle- Egg, Larva, Pupa and Adult. Larva of a butterfly is known as caterpillar and pupa is also known as chrysalis. Butterflies have short life spans of nearly one month but again it is dependent on the species. Butterfly tends to show one or more broods per year and hence exhibit multivoltinism.

AIM AND OBJECTIVES

AIM: To study and evaluate Butterfly diversity with respect to habitat preference and seasonal variation in various selected habitats of Ranchi.

OBJECTIVES:

1) To identify documented Butterfly species taxonomically from different habitats of Ranchi.
2) To evaluate & compare Butterfly species with respect to various selected habitats of Ranchi.
3) To evaluate effects of major climatological seasonal factors i.e. maximum average temperature and average monthly rainfall on observed number of Butterfly species with respect to different habitats of Ranchi.

Feasibility Study Need of the Butterfly Park in Jharkhand:

The land of forests is rich in bio-diversity as a part of Chhotanagpur Plateau province of the Deccan Peninsula Bio-geographic Zone. The recorded forest area is 2.36 million hectares which constitutes 29.61% of the geographical area of the state. The Chhotanagpur Plateau is especially rich in forest resources. So, this region provides a suitable tropical habitat for butterflies of different sizes, shapes, colours and patterns, and they are so developed to survive in such natural forest habitat. Presence of butterfly in good number is an indicator of a perfect natural environment. Urban areas of Ranchi, Jamshedpur, Bokaro, Dhanbad and others have lots of small and big industries which are polluting the environment (as per Jharkhand Biodiversity Board). Butterflies have an important role to perform in promoting awareness o the increasingly urgent need for biodiversity of the terrestrial ecosystem: 1. The appearance of butterfly is of an aesthetic and ecological value. 2. The existence of butterfly in the environment are mentioned to be pollinators of plants, food sources for other animals and also has an

important role in scientific discoveries. 3. Unfortunately, environment disturbance overcome decrease of the butterfly population. Environment disturbance is a change in environmental components forming the habitat thereby affecting the ecosystem imbalance and biotic communities inside. 4. In order to reduce the impacts of disturbance, the thematic garden is needed, such as the ecological park (eco-park), or butterfly park.

STATE OF JHARKHAND- AN OVERVIEW

Jharkhand is located between 83˚-22' - 87˚-57' Latitude and 21˚-58' - 25˚-18' Longitude. The tropic of CANCER at 23½˚north passes through RANCHI district [at ORMANJHI]. The State is situated at on average height of 1000 ft. above Sea level and the State Capital, Ranchi was used to be summer capital of erstwhile Bihar. The Geographical area of Jharkhand State is 79,714.00 Sq. KMs. The climate here is generally dry with average rainfall of 1500 mm. The temperature varies between 18˚C to 29˚C, however with Global Warming; average temperature goes as high as 45˚C and at times going as low as 2˚C. The fertile soil here is generally Red and yellow with some amount of sand. But most of the terrains are rocky covered with pebbles. This acts as a check on fertility of soil. The State is surrounded by West Bengal at its East, by Chhattisgarh and Uttar Pradesh at its West, by Bihar in the North and by Orissa at its South. The physiographic characteristics of the State are rich. It has waterfalls, lakes, hills etc., which have tourist values. The rivers Swarnrekha, Koyal, Shankh and Damodar flow through the State and are utilized for irrigation at many places. 'JHARKHAND' State was carved out of erstwhile Bihar. This 28th State came into existence on 15th November 2000. From administrative point of view Ranchi is the State capital.

GEOGRAPHY

Most of the state lies on the Chota Nagpur Plateau, which is the source of the Koel, Damodar, Brahmani, Kharkai, and Subarnarekha rivers, whose upper watersheds lie within Jharkhand. Much of the state is still covered by forest. Forest preserves support populations of tigers and Asian Elephants. Soil content of Jharkhand state mainly consist of soil formed from disintegration of rocks and stones, and soil composition is further divided into: Red soil, found mostly in the Damodar valley, and Rajmahal area Micacious soil (containing particles of mica), found in Koderma, Jhumri Telaiya, Barkagaon, and areas around the Mandar hil Sandy soil, generally found in Hazaribagh and Dhanbad Black soil, found in Rajmahal area Laterite soil, found in western part of Ranchi, Palamu, and parts of Santhal Parganas and Singhbhum.

CLIMATE

There are three well-defined seasons in Jharkhand. The cold-weather season, from November to February, is the most pleasant part of the year. High temperatures in Ranchi in December usually rise from about 50 °F (10 °C) into the low 70s F (low 20s C) daily. The hot-weather season lasts from March to mid-June. May, the hottest month, is characterized by daily high temperatures in the upper 90s F (about 37 °C) and low temperatures in the mid-70s F (mid-20s C).

WATER RESOURCES

Although three important rivers namely Swarnrekha [North and South], Koyal and Shankh flow in the State they are not deep enough to be used for transportation. Navigational facility does ensure easy movement; it is however, not the demand of the hour. They are important from irrigation point of view. The State authorities have also taken steps to store run-off water for water harvesting.

Although good irrigation facility does not exist for agriculture sector, industries do get adequate amount of water supply. During investigation, it was revealed that the important towns and Kasbah don't face any problem in getting water supply. The water availability position has further been strengthened by inflow of tube-well digging machines mounted on trucks, from south – Andhra Pradesh, Tamil Nadu etc. It costs around 40 –45 thousand of rupees to have a tube well dug by these machines, depending upon the depth of water level below the surface of the Earth. Thus, it can be concluded that there would not be any problem for the industries requiring water for industrial purpose. Further, the State has normal rainfall pattern of 1400 mm spread across the whole region.

SOIL CONDITION

The soils of the district are mostly of the residual type. High temperature and high rainfall have led to the formation of lateritic type of soils from rocks of Archean metamorphic complex exposed in the greater part of the district. Texturally the soils of the district have been classified into four classes1. Stony and gravelly soils--- These are low grade soils having a large admixture of cobbles, pebbles and gravels generally found at the base of the hills. 2. Red and yellow soils: - This soil is formed by the decomposition of crystalline metamorphic rocks like granite- gneiss etc. These rocks contain mineral particles like biotite, hornblende and iron. Higher areas have soils with light red color but the lower areas have relatively dark color. It

lacks nitrogen, Phosphorus acid and humus. Potash and lime are sufficiently found. 3. Lateritic soils: - This type of soil is found in Ratu, Bero and parts of Mandar Blocks. The soil has dark red or brown colour, It has high iron content and has been formed by the process of lateritisation of the weathered material in the favourable climate and topography. 4. Alluvial soils: - River channels in the district are covered with alluvial soils consisting mainly of coarse sand and gravel mixed with silt and clay. Soil thickness depends upon the topographical control.

FOREST RESOURCES

Jharkhand State is well endowed with forest in an area of 18423 Sq. Kms which is 23.11% of total area. Forests are an important natural resource for an area. They have a moderating influence against floods and rain and thus they protect the soil against erosion. They also provide basic raw material to a number of important industries, namely furniture, match box, paper, rayon construction, railway slippers, wooden poles, etc. Moreover, the environmental benefits of the forests are not far to seek. The forests in whole of the State and especially in Chhotanagpur region also have good number of animals such as deer, elephants, bears etc. Although a good number of government policies exist for protection of Forest, no serious attempt has been so far made for its preservation. The most unfortunate part is that the Tribal in much area still depend on forest as a source of firewood. They don't have any other option either. The wood smugglers and Dons still go for illegal felling of trees causing a great loss both to the people of the area and to the state exchequer simultaneously. Not only this, there have been instances of poaching of animals by the smugglers to acquire invaluable materials such as tiger's skin and elephants tusk, those command high price in the International market, although the poaching is not at very large scale.

STUDY AREA

The present research work will be carried out for a period of 2 years i.e. 2021 -2023. Different habitats will be selected from different location of Ranchi district for the Butterfly study namely- horhap forest, Bhagwan Birsa Biological Park, Ormanjhi, Rajaulhatu forest area, Jharkhand Biodiversity Park-Ranchi. Major fragmented habitats along with the sub-habitats are depicted in the map of Ranchi District as Figure: A & B.

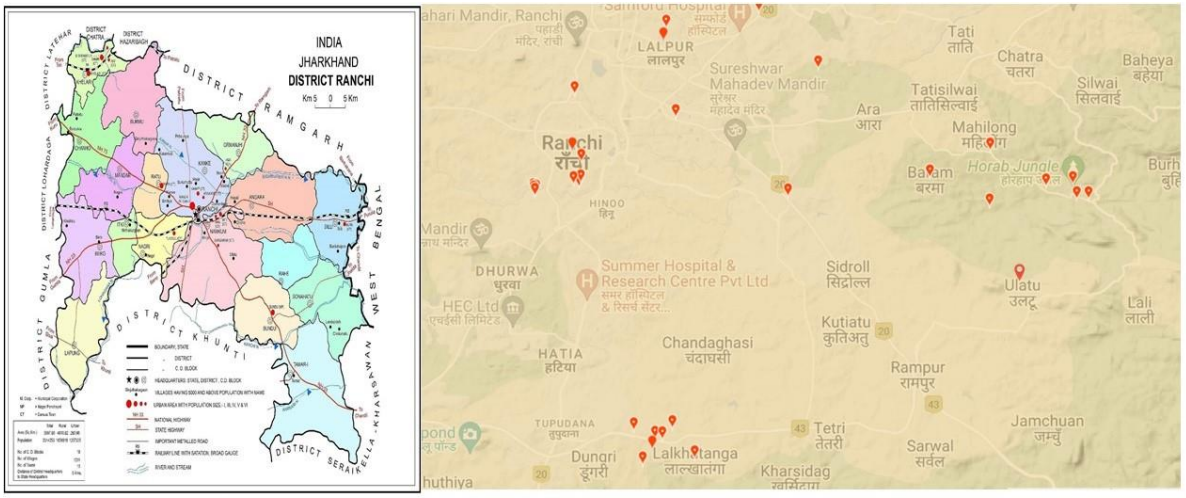

Figure: A: Map of Ranchi & Figure B: Selected Area for Butterfly Study

Table 3: List of plant resources utilized by butterflies in Ranchi

Sl No	Botanical Name	Local Name
01	Clerodendron	Ghato
02	Cynodon dactylon	Dhub grass
03	Lantana camera	Putush
04	Tamarindus indica	Imli
05	Ficus glabella	Putkal
06	Ficus bengalensis	Bargad
07	Artocarpus heterophyllus	Kathal
08	Syzygium cuminii	Jamun
09	Ficus religiosa	Peepal
10	Shorea robusta	Sal
11	Ageratum conyzoides	Kokroudha
12	Plumeria acutifolia	Gulaichi
13	Pongamia pinnata	Karanj
14	Melia azedirach	Bakain
15	Holarrhena antidysentrica	Koraiya
16	Madhuca longifolia	Mahua

BOTANICAL GARDEN

Biodiversity Park, Ranchi is developed with an aim to conserve rare and imperative plants, trees and medicinal herbs. India used to be one of the main places of herb, shrubs and tree plantation. The main objective is to preserve these rare medicinal herbs and plants as conservators of our natural resources and their protection for next generation. The park is developed in the huge area of 542 acres of land with proper distribution of parks, gardens, medicine conservation, animal preservation area and other such.

SAMPLING PROTOCOL

Pollard- Walk Method

Systematic approach will be followed to monitor the Butterfly study. During the entire study of three years, Pollard Walk method was utilized to document the butterflies though with modification. Pollard Walk method states that each fixed path is walked along a fixed duration time. In the present study, selected path visits were made during the morning time i.e. 900-1200 hours and later at 1500-1800 hours. Each path is walked upon for a period of 2-3 hours and the visibility of 10 meters was kept at both the sides of the path. Visual encounters were made during the entire study period. Butterfly collection was made whenever butterflies were unidentified on field sessions. Butterflies were observed along the pedal paths which separate two agricultural fields and were observed on both the sides of the paths.

Collection of Data

To study the effect of different seasons on the diversity of butterflies, seasonal monthly visits were made to the selected fragmented habitats like the urban residential, agricultural landscapes, industrial vicinity, botanical garden and hill station. The months were quarterly divided into pre-monsoon, monsoon and post monsoon season. February, March, April and May are considered as the pre-monsoon months. Whereas June, July, August and September months form the monsoon season. October, November, December and January form the post monsoon season. During the visit to the selected fragmented habitats, the maximum temperature and rainfall data was obtained. Hence, the average maximum temperature and average monthly rainfall details of three years i.e. from 2011 -2014 were utilized for monthly comparative study with respect to the observed number of butterfly species.

PHOTOGRAPHING BUTTERFLIES

One of the most pleasant aspects of studying butterflies is capturing them digitally garnishing with some patience. Butterfly photography will be done using Sony Cybershot DSC- W220 with 12.1 megapixels and 4X optical zoom. Along with that, Lumix Panasonic DMC-FZ 60 with 16.1 megapixels and 24X Optical Zoom was also utilized for photographing small sized butterflies. Required editing of photographs will be done using essential softwares.

Taxonomical Identification of Butterfly Taxonomic identification of the rhopalocerans using the multiple pictorial field guides as on-field identification manuals and standard reference books for their systematic identification. Pictorial guides of (Kunte, 2000), (Kehimkar, 2008) and (Parasharya & Jani, 2007) is selected for help during field visits. Standard works of (Evans, 1932) and (Wynter Blyth, 1957) will be utilized to confirm the on field identification. Expert advice will be taken as and when required for the confirm identification of species by the famous Butterfly Man of Jharkhand Er Prabhat Kumar, Ranchi. Concerned identification of host plants or nectar resources will be done by the faculty members of Department of Zoology, School of Science, YBN University, Ranchi (Jharkhand).

STATISTICAL ANALYSIS OF BUTTERFLY SPECIES DIVERSITY

Statistical Analysis of Species Diversity Alpha diversity indices will be utilized to analyse the butterfly diversity using the CropStat software. This typical diversity index states the number of species within site with the relative abundance of each species. It is defined as: $H' = \Sigma$ pi ln pi (where pi = proportion of the i th species in the total sample) Pielou's Evenness Index: This index states the distribution of the relative abundance of species in a site. It is defined as: $J = H' / \ln S$ (where S = number of species present in the site) The value of J ranges from 0 to 1. Less is the variation in communities between the species, the higher the value of J.

Beta diversity was analysed between the various fragmented habitats: Sorensen's Similarity Index: It is a simple measure of beta diversity which ranges from a value of 0 to 1. It is defined as: $B = 2c / (S1 + S2)$ (where S1 = the total number of species recorded in the first community, S2 = the total number of species recorded in the second community and c = the number of species common to both communities) If the value is 0, then there is no species overlap between the communities whereas value is 1 then, exactly same species are found in both the communities. Species richness in various sub-habitats of the selected fragmented habitats was graphically compared so as to signify the Butterfly habitat preference. Seasonal distribution of Butterfly amongst all the selected fragmented habitats were graphically represented combining

all the 3 major components namely the temperature, rainfall and documented species of the fragmented habitat.

OUTCOMES OF THE RESEARCH STUDY

The proposed Research work with its tenure in Ranchi coincides with the major seasons, which will be contrasted in the current study, along with the diversity of butterflies. The results of this study will show how important green spaces in urban infrastructure outside of cities are for supporting a variety of butterflies.

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